

- RICHTER, H. (1965): Die Unterscheidung von *Neomys anomalus milleri* Mottaz, 1907, und *Neomys fodiens fodiens* (Schreber, 1777) nach dem Hüftbein (*Os coxae*) nebst einer Mitteilung über neue Funde erstgenannter Unterart aus dem Erzgebirge und dem Vogtland und Ostthüringen. Säugetierkd. Mitt. 13, 1-4.
- RUPRECHT, A. L. (1971): Taxonomic value of mandible measurements in Soricidae (Insectivora). Acta Theriologica 16, 341-357.
- RZEBIK, B. (1968): *Crocidura* Wagler and other Insectivora (Mammalia) from the quaternary deposits of Torneton Cave in England. Acta zool. Cracov. 13, 251-263.
- SCHAEFER, H. (1975): Die Spitzmäuse der Hohen Tatra seit 30 000 Jahren (Mandibular-Studie). Zool. Anz. 195, 89-111.
- SCHMIDT, E. (1969): Über die Koronoidhöhe als Trennungsmerkmal bei den *Neomys*-Arten in Mitteleuropa sowie über neue *Neomys*-Fundorte in Ungarn. Säugetierkd. Mitt. 17, 132-136.
- VESMANIS, I. E. (1976): Vorschläge zur einheitlichen morphometrischen Erfassung der Gattung *Crocidura*, Insectivora, Soricidae als Ausgangsbasis für biogeographische Fragestellungen. Abh. Arbeitsgem. tier- u. pflanzengeogr. Heimatforschung Saarland 6, 71-78.
- WITTE, G. (1964): Zur Systematik der Insektenfresser des Monte-Gargano-Gebietes (Italien). Bonner zool. Beitr. 15, 1-35.

Anschriften der Verfasser: Dr. HARALD PIEPER, Landesmuseum für Vor- und Frühgeschichte, Archäologisch-Zoologische Arbeitsgruppe, Schloß Gottorf, D-2380 Schleswig; Dr. HANS REICHSTEIN, Institut für Haustierkunde, Universität Kiel, Olshausenstr. 40-60, D-2300 Kiel

Gestation period and parturition of the ringtail *Bassariscus astutus* (Liechtenstein, 1830)

By I. POGLAYEN-NEUWALL and INGEBORG POGLAYEN-NEUWALL

Department of Ecology and Evolutionary Biology, University of Arizona and Department of Birds and Mammals, Arizona-Sonora Desert Museum, Tucson

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Abstract

Studied the gestation period and parturition of *Bassariscus astutus*. Six ♀♀ were observed and their reproductive behavior was recorded. Both sexes reach sexual maturity at the age of approximately 10 months. The annual breeding season extends from February into May, with the majority of matings taking place in April. The ♀ is receptive during a 24-hour period only, which coincides with the peak of the estrous swelling of her vulva. If conception has occurred, vulval swelling commences again a few days after the termination of the estrus cycle and shows another peak at the time of parturition. Thus recurring vulval swelling is an indication of pregnancy in addition to mammary development and increased abdominal girth.

The gestation period in this species varies from 51 days and 8 hours to 53 days and 14 hours, and parturition may last from 85 to 126 minutes. This is the shortest gestation period among Procyonidae.

No post-partum estrus with copulations has been observed even after the loss of neonate young.

Introduction

The ringtail (*Bassariscus astutus*) is the one genus of the family Procyonidae whose gestation period has remained unknown. Also there exists no published description of the parturition in this species.

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Bassariscus being a geologically, virtually unchanged form since the late Tertiary may serve as a hypothetical model for physiologically and behaviorally more primitive ancestors of modern Procyonidae.

To this end the authors have strived since 1971 to assemble as large a number of ringtails as practical, covering all ages and including two different races in order to investigate all aspects of their behavior and physiology that can be researched under conditions of captivity. This research is still in course.

Material and methods

Eight ♂♂ and ten ♀♀ ringtails were maintained over periods of up to three and one half years in outdoor cages and their behavior and breeding biology were investigated.

The gestation periods were determined in the following manner: at the approach of the breeding season, beginning in early March, each ♀ was visually inspected daily for morphological and behavioral changes indicating estrus. When vulval turgidity was noted in an animal, the particular pair was watched every evening until about midnight and their general behavior was recorded. The cages were illuminated by 100 W red lights to facilitate observation without disturbing the animals. A typical staccato mating chitter, audible up to a distance of about 40 m was uttered by the ♀♀ in all nine copulatory episodes. This vocalization was also observed by BAILEY (1974). The colony of ringtails was set up in enclosures within hearing distance of the authors' home in N. E. Tucson. Each pair of ringtails was housed in a cage of 2 × 2 × 2 m. During the winters 1977/78 and 1978/79 ♂♂ were kept in individual cages without visual or olfactory contact with the ♀♀; this was done in an attempt to simulate a situation suspected to occur in most cases in the wild, and hoping that this would enhance breeding in the following spring.

Copulations of any given pair took place within a period of 24 hours or less. BAILEY (1974) found one case when they extended over 36 hours. In two cases ♂♂ were removed 24 hrs. after copulations had taken place, in one case 3 days later, in one case the ♂ remained with the pregnant ♀ through parturition, and in all other cases the ♂ was removed 3 to 5 weeks after copulations had occurred. On days and nights when copulations occurred and on the day afterwards a watch around the clock was maintained.

Results

Gestation periods¹

Female No. 1 (♀ 1), *Bassariscus astutus arizonensis*, at least 7 years old, six of which it spent in captivity, was mated with a ♂ *B. a. arizonensis*, taken in January 1976 as an adult within the city limits of Tucson. This ♀ gave birth to a litter on 29 May 1978, after a gestation period of 52 days. Parturition was not observed and only one mutilated young was found after an absence of 2 hrs. by the observers. Birth must have taken place between 14.00 and 16.00 hrs.

A two-year old, captive-born, mother-raised ringtail, (♀ 2), *B. a. flavus*, gave birth to a litter of three (1 ♂, 2 ♀♀) on 18 June 1977, after a gestation period of 51 days, 11 hrs. Its mate was a *B. a. arizonensis* of unknown age, captured in Tucson in October 1975. On 2 June 1978 this same pair had a second litter consisting of 2 ♂♂ and 2 ♀♀ after a gestation period of 51 days, 8 hrs. A third litter of 3 ♀♀ was born on 11 June 1979, after a gestation period of 51 days, 4 hrs.

A female (♀ 3), *B. a. flavus*, wild-born, hand-reared and received in March 1976 at the age of 22 months, had to undergo removal of a litter by cesarian section on 15 June 1978, after a pregnancy of 53 days and 14 hrs. The two fully developed live ♂ young weighed 30.3 g and 29.2 g. The placenta weighed 15.4 g and 9 g respectively. This ♀ had a second litter of two (♀, ♂) on 10 July 1979, after a gestation period of 52 days, 4 hrs. The sire was in both cases a *B. a. arizonensis* which was trapped in the foothills of the Sta. Rita Mts., south of Tucson, in November 1975.

A wild-caught, pregnant female (♀ 6) *B. a. arizonensis*, trapped in May 1978 in the Chiricahua Mts., S. E. Arizona, had a litter of 3 ♀♀ on 1 June 1978. This ♀ was paired in 1979

¹ All gestation periods are calculated from the time of the last copulation.

with a ♂ *B. a. arizonensis*, taken as a juvenile (testes had not yet descended) in 1978 near the base of Picacho Peak, west of Tucson, and at the time of mating (16 April 1979) approx. 10 months old. Two ♂♂ and 1 ♀ were born to this ♀ on 8 June 1979, after a gestation period of 52 days, 5 hrs.

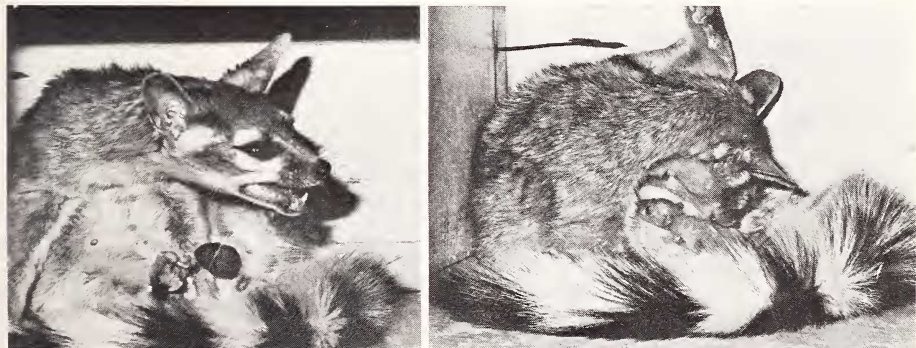
Two of the three ♀ young (♀ 7 and ♀ 8) born to ♀ 6 in 1978 had their first estrus cycle in 1979 and both were bred by the mate of ♀ 2. Parturition of ♀ 7 was not observed but must have taken place on 24/25 June 1979 after a gestation period of little over 51 days, judging from the fresh blood smears in the nest box. An unknown number of young were born and immediately consumed by one or both ♀♀ 7 and 8 which were kept together. Two young were born to ♀ 8 on 26 June 1979 between 2.00 hrs. and 4.00 hrs., after a gestation period of 52½ days. These young disappeared a few hours later.

Parturition

Because of the lack of literature information on observed parturitions and the variability of behavior and duration of this process, all episodes will be described in appropriate detail.

Initial labor was characterized in all instances by periodic chittering, extreme restlessness and licking of the vulva. This stage lasted from 15–54 minutes. Series of staccato chitter occurred on the average every 1–3 min. and lasted from 0.5 sec. to 4 min. There were about 4–5 bursts per sec. Restlessness was manifested by frequent changes of position inside the nest box (circling, rolling onto back and stance with arched back). Rather infrequently an animal left the nest box, ran along branches and rapidly paced on the cage floor. This stage corresponds to the “preparation of birth” as classified by NAAKTGEBOREN and SLIJPER (1970). It immediately precedes actual labor, the “dilation period”. However, the transition was always so subtle, the end of one phase and the beginning of the other impossible to determine. At times the preparatory phase was quite brief or appeared to be absent altogether. For these reasons it was deemed convenient to disregard any real distinction between the preparatory and dilation phases in this species.

In time licking over the genital area intensified; for this purpose the animal was positioned on her lower back, tail laid forward between the hind legs and one or both hind legs stretched forward or one forward and one up. At the same time the animal braced herself with one foreleg on the ground while the other was raised. No copious amounts of birth fluids or any discharge of blood (beyond a drop or two) were ever noticed. During this stage there were no visible contractions. These were also difficult to observe later during the birth process. The strain of labor, however, was clearly expressed by the volume and duration of the chitter. Ac-



Ringtail during parturition. *a* (left): ♀ uttering chitter vocalizations; head of fetus protruding from vaginal orifice; *b* (right): ♀ grooming neonate and genital area. Young is searching for teat

tual expulsion of fetuses lasted from 2–47 min ($n = 13$, $\bar{x} = 14$ min). The interval between the expulsion of the fetuses ranged from 7–49 min ($n = 10$, $\bar{x} = 24.4$ min). Placentophagia took 1–3/4 to 4–1/2 min.

Case 1, ♀ 2 (primiparous), 18 June 1977

- 7.11 h: onset of labor.
- 7.48 h: forceful chitter; ♀ sits on lower back with hind legs stretched forward, head of fetus emerged.
- 7.55 h: ♀ grasps head of fetus with teeth and pulls out fetus with placenta attached; eats placenta.
- 7.58 h: young vocalizes for the first time; ♀ cleans herself around vulva and licks young. She touches young twice with hand.
- 8.00 h: ♀ grooms her back, emits clucking vocalizations directed at the observer and pulls young with hand close to her abdomen and curls around it.
- 8.08 h: ♀ chitters, becomes restless again.
- 8.12 h: strong chitter of ♀; head of second fetus appears in vaginal orifice. No visible contractions.
- 8.16 h: fetus and placenta glide out.
- 8.22 h: second young vocalizes.
- 8.24 h: first-born young holds briefly on to teat with its mouth.
- 8.35 h: second young is nursing.
- 8.37 h: ♀ chitters; onset of renewed labor.
- 8.40 h: strong chitter; fetus is expelled (mode of presentation uncertain).
- 8.45 h: afterbirth is expelled and consumed. Now follows a prolonged period of autogrooming of the ♀ and occasional grooming of the young by the mother.

Case 2, ♀ 2 (second litter), 2 June 1978

- 10.00 h: onset of labor.
- 10.15 h: several contractions and forceful chitter; tail of fetus emerging. Vigorous licking by the ♀ removes birth membranes (which are swallowed) and contributes in extracting the fetus.
- 10.17 h: fetus is expelled. ♀ licks young which vocalizes, then bites off umbilical cord. ♀ licks her vulva intensively, then grasps young with mouth around head-neck-shoulder region and deposits it with one hand against a teat. Young nuzzles abdomen of ♀ with shaky lateral movements of the head.
- 10.33 h: strong chitter of the ♀ alternating with clucking vocalizations. She rolls over onto her back, both hind legs are stretched out, and bends forward to reach and consume the protruding placenta.
- 10.46 h: very loud chitter, four contractions at 10 sec. interval; licking over vulva; tail of fetus protruding. Vigorous licking continues.
- 10.48 h: young is free. ♀ cleans young and her genital area.
- 10.51 h: alternating chitter with straining and licking.
- 11.00 h: placenta is expelled and devoured.
- 11.03 h: ♀ chitters, is restless and changes position frequently. The young vocalize and are retrieved with a hand as the ♀ circles.
- 11.06 h: forceful chitter of ♀, much vulval licking and straining; ♀ stands up . . . tail and hindquarters of third fetus are free. Strong movements of fetus . . . arms and forebody are free, head is still inside vagina.
- 11.08 h: ♀ strains and expels the fetus completely.
- 11.09 h: two contractions; afterbirth is expelled and eaten at once. ♀ settles in lateral "halfmoon" position, licks the young, her anogenital region and the base of her tail. She cleans her face with both hands simultaneously (bilateral head wiping of rodents, felines, viverrids and marsupials) and arranges the young close to her abdomen. Two of the young have already found the teats and hold on to them intermittently.
- 11.21 h: strong chitter of ♀ and three contractions.
- 11.22 h: head of fetus visible in extended vaginal opening.
- 11.23 h: fetus is partially expelled, except for hind legs and tail.
- 11.26 h: ♀ licks intensively over fetus and umbilical cord. She stands up, circles, sits down on her lower back, grasps the partially extruded fetus with both hands and positions it with its head against her abdomen.
- 11.37 h: forceful chitter of ♀; fetus and placenta are expelled simultaneously; the latter is consumed immediately and the cord is severed. Autogrooming around vulva. ♀ circles once more, assumes later halfmoon position around young, which she assembles with her hands and/or mouth; some of the young suckle and all are cleaned by the ♀.

Case 3, ♀ 2 (third litter), 11 June 1979

- 8.29–9.19 h: repeated chitter (11 sequences from 2–180 s) indicating labor.
 9.20 h: head of fetus appears in vaginal opening.
 9.30 h: ♀ grasps fetus with teeth around head and pulls it out.
 9.33 h: placenta is expelled and consumed.
 9.43 h: three-minute sequence of chitter. Tail and hind legs of second fetus appear in vaginal opening. The fetus is oriented with its spine toward the ♀'s spine.
 9.46 h: chittering continues, the fetus is pressed out to its pelvic region.
 9.47 h: young is expelled completely.
 9.48 h: placenta is expelled and placentophagia commences.
 9.51 h: after one min. of chittering the third fetus appears, occiput first, with the same orientation to the parturient ♀ as the second fetus.
 9.54 h: fetus is pressed out to its pelvis and a few seconds thereafter is completely free; the placenta follows immediately, is consumed by the ♀ and the umbilical cord is severed close to the abdomen of the neonate.
 9.56–10.0 h: intensive licking of young and perigenital area of ♀.
 10.01 h: ♀ pulls two young, one at a time, with the mouth to her groin and retrieves the third young with her hand, also placing it next to the mammary area. The ♀ then curls latero-ventral around the young, her tail forming a semi-circular, protective barrier, insurmountable for the young.

It could not be observed when these young suckled for the first time. No blood was seen during labor/expulsion. Small amounts of amniotic fluid discharged intermittently were licked off the vulva and the floor of the nest box.

Case 4, ♀ 3, 10 July 1979

- 3.10–3.27 h: during this "preparatory phase" the ♀ utters frequent series of low level chittering (10 sequences from 0.5 s to 50 s).
 3.27 h: ♀ leaves birth box briefly to inspect sleeping box 60 cm away (openings face each other). She utters 2 chitter sequences of 50 s and 60 s at a somewhat higher volume.
 3.30–3.48 h: the ♀ grows progressively restless, utters 23 chitter sequences but remains in birth box.
 3.48 h: ♀ licks her vulva, ♂ joins ♀ for a few s in birth box.
 3.49–3.57 h: ♀ alternating licking of vulva, chittering and circling.
 3.57 h: ♀ licks intensively over vulva; leaves box and moves onto adjacent resting shelf . . . head of fetus appears in vulva. 48 s later about half of the body length of the fetus is protruding.
 3.58 h: ♀ grasps fetus between jaws around the middle of the body and jerks it out. She now carries the young into the birth box and stays with it for about 30 s.
 4.00 h: ♀ climbs down to cage floor, approaches ♂ and sniffs it nose to mouth, then anally and follows ♂ around the cage. No agonistic intentions are recognizable.
 4.02 h: ♀ returns briefly to birth box, leaves again after a few sec. and follows ♂.
 4.04 h: ♀ grasps young with teeth and carries it into sleeping box. She then commutes thrice between sleeping box and birth box with young in mouth, runs along branches and finally deposits young in sleeping box but leaves it right away.
 4.10 h: ♂ enters sleeping box and leaves 5 s later.
 4.11 h: ♀ marks on horizontal branch with "perineal drag", climbs to floor and intensively sniffs at placenta (which had torn and dropped to the floor) but does not consume it. She then follows the ♂ again sniffing it anally.
 4.13 h: both ♂ and ♀ commute three times between the boxes; the ♀ returns to the placenta (weight: 7.2 g) and sniffs at it for 40 s.
 4.23 h: ♀ marks on same spot of branch as previously by lowering and touching it with her perineal region.
 4.25 h: ♀ enters birth box and begins to chitter very forcefully (6 sequences). She licks over her genital area and circles on the spot.
 4.33 h: two chitter vocalizations and several contractions: tail and hind feet of second fetus protrude from vaginal orifice. ♀ chitters again, pivots on the spot and licks fetus.
 4.37 h: fetus is expelled more than midway. ♀ chitters on and off.
 4.46 h: fetus is free.
 4.47 h: 30 s: placenta is expelled and ♀ commences to consume it. ♀ makes no effort to clean or nurse the second young either.
 4.52 h: ♀ leaves birth box and runs around cage.
 4.59 h: ♀ returns to birth box, licks young briefly and licks intensively over her vulva. First-born young lies all the while unattended in the sleeping box. ♀ leaves box 20 s later, approaches ♂ and grasps him with the teeth by the skin of the nape trying in vain to "retrieve" him into birth box.

- 5.05 h: ♂ follows ♀ into birth box where he remains with ♀ and second young until 5.22 h.
 5.23 h: observer recovers first young from sleeping box. The young, a ♀, has a deep puncture wound on the rib case, it is cold and hardly moves.
 5.28 h: ♂ and ♀ join in sleeping box.
 6.45 h: parent animals are still in sleeping box (where they will remain until dusk). It is therefore decided to remove the second young, a ♂, for hand-rearing as well. This young has a bloody, superficial tooth mark on the skull above the eye.

The ♂ has never actively interfered with the birth process or with the young, although his mere presence could have influenced the behaviour of the ♀, and caused a stress situation detrimental to the survival of the young. The ♂ is not tolerated by all pregnant ♀♀ up to (and perhaps beyond) parturition. E. g. ♀ 2 showed increasingly aggressive behavior toward her mate, beginning about 4 weeks postcopulam, and one week later the ♂ had to be removed.

Case 5, ♀ 6, 1 June 1978

4.30 h (early dawn): onset of labor evidenced by loud staccato chitter. While it was not possible to observe this shy ♀ closely, duration of labor and moments of individual births can be deduced from the volume and duration of the chitter vocalizations. Thus initial labor may have taken from 4.30 till 5.29 h (54 m), at which point the first young was expelled. The second young was probably born at 5.50 h, the third young by 6.30 h and the last placenta was passed at 6.36 h.

Case 6, ♀ 6 (second litter), 8 June 1979

3.30–9.35 h: 27 bouts of chitter vocalizations are recorded, individual sequences lasting up to 4 m. While uttering these vocalizations the ♀ remains exposed on the top of her nest box or crouched on a branch. No contractions can be discerned during what may be identified as "preparatory phase".

8.20 h: ♀ enters the nest box and so withdraws from observation².

8.55 h: a check by the observer reveals the absence of any young.

9.45 h: parturition (expulsion) is in course; the last of 3 young (2 ♂♂, 1 ♀) is born at 10.58 h.

Because of the extended, poorly defined preparatory phase and the uncertainty about the beginning of actual labor, the duration of this parturition must remain undetermined.

Discussion

Pregnancy becomes recognizable when teats begin to swell and the areolas become somewhat enlarged, bare of hair and elevated. This is noticeable about 20 days before parturition. The increase in girth of the abdomen is very gradual, at around 35–40 days after copulation it becomes conspicuous in many cases and the animal then moves with less agility. We found no definite correlation between degree of distension of the abdomen and number of fetuses. Until this time the gestation period of this North American carnivore was only a matter of conjecture. DAVIS (1960) assumes the pregnancy to last 45–50 days. LÖHMER (1976) reports a gestation period of "about 61 days". He later (pers. comm.) explained this statement as his mistaken interpretation of the text in RICHARDSON'S (1942) paper. J. H. KAUFMANN (pers. comm.) recounts the following observations on his Texas ringtails, which he kept for several years in the laboratory at the University of Florida in Gainesville: "In 1969 my oldest ♀ gave birth to one young on 15 May but ate it after 6 days. The ♂ was replaced in her cage at that time. . . . On 14 July she gave birth to two young which were successfully raised." This would indicate a gestation period of no more than 54 days as well as demonstrate that in exceptional cases ringtails may have a post-partum estrus.

No post-partum estrus was observed in ♀ 2 which lost her young of the 1977 season just 24 h after parturition and again in 1978 when the young were removed 48 h post-partum. Neither was there a post-partum estrus in ♀ 3 after her cesarian section in 1978 nor after the

² In several instances a nest box was used with an acrylic top and side which allowed observation of the birth process occurring inside the box. The side was hinged like a door and could be opened for even better observation and photography.

removal of the young only hours after parturition in 1979. Furthermore no post-partum estrus was recorded for ♀♀ 7 and 8.

A ♀ *B. a. arizonensis* trapped on 7 March 1979 in the foothill region of the Sta. Catalina Mts. showed conspicuous vulval swelling at the time of capture, which continued through parturition until 25 days post-partum. This may indicate a (weak ?) post-partum estrus in this ♀. A ♂ trapped in the same place within 24 h of the ♀, showed no sexual interest in this ♀ at any time. The litter of this ♀ (1 ♂, 3 ♀♀) which was born between 8.00 and 10.00 h of 19 April in the presence of the ♂ (which showed no aggression toward the new-born young) was removed upon discovery. This seems to be the earliest birth on record for the state of Arizona.

An interesting observation relative to the gestation in this species deserves mention: as a rule hormone-induced morphological changes of the vulva are indicative of the mammalian estrus period and subside at the end of the cycle whether or not conception has taken place. However, in *Bassariscus astutus*, when conception has occurred, vulval swelling will invariably recur several days after the termination of the cycle. For ♀ 2 swelling recurred at the 7th day after the end of the cycle or 23 days before parturition. For ♀ 3 vulval swelling occurred at 4 days or 32 days before parturition. For ♀ 6 the new swelling started at 18 days or 21 days before parturition; for ♀ 7 at 21 days post-cycle, or 22 days before parturition. For ♀ 8 it was noted at 14 days or 25 days before parturition. This second swelling reached climax at the time of parturition and the vulva assumed anestrus proportions again 5 days post-partum (♀ 2, ♀ 3), 7 days post-partum (♀ 7), 8 days post-partum (♀ 2, ♀ 8) and 11 days post-partum (♀ 3).

The second vulval swelling, consequently, is a result of successful conception, and is as reliable in this species as the extension of teats, enlargement of mammary glands and distension of the abdomen.

It shall be noted that in some mustelids, vulval swelling may persist far beyond the normal duration of estrus if no conception occurs (POGLAYEN-NEUWALL 1975).

Any visual perception of the ♀'s swollen vulva by the ♂, if it does occur, is limited and confined to the estrus period when the ♂ stays near the ♀, when the ♀ voids, or the ♂ sniffs her genital area. There is little doubt that the ♂ receives primarily olfactory cues. Pheromones may emanate from glands in the vulva/vagina region and from the anal glands; these pheromones are mixed with urine and scats as well. It can be assumed that also during the period of the second vulval swelling pheromones are released from this particular area. There are several interpretations possible of this phenomenon:

a. The olfactory message conveyed could mean to a ♂ "this ♀ is already pregnant, stay away". This would be in line with the findings of TOWELL (unpubl. ms.) who radio-tracked 3 ♂♂ and 5 ♀♀ (incl. 3 pregnant ♀♀) in the Edwards Plateau region of Texas. While ♂ home ranges overlapped those of ♀♀, he did not observe adult animals to den together at any time. The ♀♀ were caring for their offspring apparently unaided by the ♂♂. Also GRINNELL et al. (1937), PARKINSON (cit. in GRINNELL et al. 1937) and TRAPP (1978) report communal denning only for a ♀ with young or siblings after social weaning from the mother.

b. Pheromones released could reinforce an existing bond between a "mated pair" and thus keep the ♂ near the ♀ during gestation. This would make biological sense only if the swelling would extend much beyond the time of parturition, especially if the presence of the ♂ would benefit the young by his contributing to their provisioning and protection. There is no conclusive evidence that this is the rule in the wild, neither has it ever been observed under conditions of captivity. Notwithstanding the above statement there are two reports that hint that ♂ and ♀ may stay together through the mating season and during the development of the young in some cases. The cabin of FRY (1926) in the Sequoia National Park, California, was adopted in late May by a pair of ringtails, where the ♀ subsequently had a litter of three. For 3 days the mother would not permit the ♂ to come near the young but later the family occupied one bed. When the kittens were 3 weeks old the parents began to bring in food and at the age

of 8 weeks the young accompanied their parents on nightly hunts. LEMOINE (1977) who studied ringtails in Trinity Co., California, tells of a ♂ denning in an attack with a ♀ and her young. Occasionally, this ♂ accompanied ♀ and young on foraging trips. This pair bond lasted for several years.

TRAPP (pers. comm.) recounts an observation relevant to the relationship of a ♂ and a gravid ♀ he captured during 2 consecutive nights in the same location using the same trap. The animals were fully compatible from the start, sharing the same nest box. They had free run of the house. When the ♀ gave birth, she kept the ♂ at bay for about 2 weeks. He then joined mother and young and was allowed to share the nest box with the young even while the ♀ was in another part of the house, until the time of his release which happened prior to weaning of the young. Thus unfortunately no observations were possible to ascertain whether or not the ♂ would have participated in providing the young with food.

The results of an investigation of ringtail ecology and movement in the Zion National Park, Utah, with the help of radio telemetry, by TRAPP (1978), were not dissimilar to those obtained by TOWELL in Texas (1976) where ranges and denning habits of ringtails are concerned: range overlap of ♂♂ with those of ♀♀, animals denning singly.

Another report by TRAPP (pers. comm.) tells of a ♀ and a ♂ ringtail which often visited a feeding station at a cabin near Bryce National Monument, Utah, during a period of nearly 8 years. Sometimes the animals (individually identifiable) arrived together, at other times separated by a few minutes and at times only one of them would show up. The ♀ also brought her young of the year along on many occasions. This, however, represents no proof that there actually was a permanent association between the ♂ and the ♀ and her young. The ♂'s range could have overlapped that of the ♀ and he could have discovered the feeding station independently.

c. Since ringtails mark with urine (POGLAYEN-NEUWALL 1973) and also mark trails and boulders near denning sites with their scats (GRINNELL et al. 1937; TRAPP 1978), probably containing secretion of the anal glands, all kinds of olfactory information should be conveyed by these means during and outside the breeding season. It is difficult to grasp the function of yet another pheromone from the genital tract which would seem an unnecessary triplication. Perhaps the explanation is a much simpler one and the vulval swelling during gestation in this species is associated with hormonal changes only and has no special communicative function at all. KLEIMAN (pers. comm.) arrives at the same conclusion for the lion tamarin (*Leontopithecus rosalia*) where the ♀♀ often show a "false" estrus in the middle of pregnancy which KLEIMAN believes to be a manifestation of changing hormonal status with no social significance.

The North American ringtail has the most rigidly defined breeding season among the 3 seasonal breeders of the procyonids (*Bassariscus*, *Procyon*, *Nasua*) with only rarely a postpartum estrus. Its tropical relative, *Bassariscus sumichrasti*, has been noted to have estrus periods in winter, spring and summer, although late winter appears to be the main breeding season (unpubl. pers. observ.). The fixed seasonal breeding season combined with the shortest gestation period among the Procyonidae assures that the gravid ♀ is physically handicapped for only a brief period, and that the young are consistently born in late spring/early summer when food is plentiful, both of definite survival value.

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Zusammenfassung

Tragzeit und Geburt beim Katzenfrett (*Bassariscus astutus*)

In vorliegender Arbeit wurde über 9 Tragzeiten von 6 nordamerikanischen Katzenfretts berichtet, die von 51 Tagen, 8 Stunden bis zu 53 Tagen, 14 Stunden, berechnet von der letzten Kopulation, betragen. Die Tragzeit dieser Art ist somit die kürzeste innerhalb der Familie Procyonidae.

Beide Geschlechter erreichen Sexualreife im Alter von ungefähr 10 Monaten. Kopulationen fanden in Perioden von 8–24 Stunden statt. Eine Lautgebung der ♀♀, charakteristisch für Paarung sowie Geburtsverlauf, wurde beschrieben. Nach Abklingen der Ödematisierung der Vulva am Ende des Östruszyklus folgt bei Konzeption eine zweite Periode der Vulvaschwellung, zu deren Höhepunkt, etwa 21–32 Tage nach ihrem Beginn, die Geburt stattfindet.

Insgesamt wurden 11 Würfe verzeichnet. Von 9 dieser Würfe wurde die Zahl der Jungen bestimmt. Unter den Würfen befanden sich 3 Zwillinge-, 4 Drillings- und 2 Vierlingsgeburten. Das Geschlechterverhältnis war 9 ♂♂ und 15 ♀♀; von 2 Jungen blieb es unbekannt.

Es wurden 6 Geburtsvorgänge an 3 Tieren vollständig oder teilweise beobachtet. Davon dauerten fünf 85, 94, 97, 97,5 und 126 Minuten. Junge wurden in Kopfendlage wie auch in Steißendlage innerhalb desselben Wurfes geboren. Mit Sicherheit wurden 6 Kopfgeburten und 5 Steißgeburten erkannt.

Zu einem post-partum Östrus mit Kopulationen kam es auch bei Verlust von neugeborenen Jungen nicht.

Literature

- BAILEY, E. P. (1974): Notes on the development, mating behavior and vocalization of captive ringtails. *Southwest Nat.* 19, 117–119.
- DAVIS, W. B. (1960): The mammals of Texas. *Texas Game and Fish Comm. Bull.* 17, 77–79.
- FRY, W. (1926): The California ring-tailed cat. *Calif. Fish and Game* 12, 77–78.
- GRINNELL, J.; DIXON, J. B.; LINSDALE, J. M. (1937): *Fur-bearing mammals of California*. Univ. Calif. Press, Berkeley.
- LEMOINE, J. (1977): Some aspects of ecology and behavior of ringtails (*Bassariscus astutus*) in St. Helena, California. Master of Sc. Thesis, Antioch College, Yellow Sprs., Ohio.
- LÖHMER, R. (1976): Zur Verhaltensontogenese bei *Procyon cancrivorus cancrivorus* (Procyonidae). *Säugetierkunde* 41, 42–58.
- NAAKTGEBOREN, C.; SLIJPER, E. J. (1970): Biologie der Geburt. Eine Einführung in die vergleichende Geburtskunde. Berlin u. Hamburg: Paul Parey.
- POGLAYEN-NEUWALL, I. (1973): Preliminary notes on maintenance and behaviour of the Central American cacomistle (*Bassariscus sumichrasti*) at Louisville Zoo. *Inter. Zoo Yearb.* 13, 207–211. *Zool. Soc. London*.
- POGLAYEN-NEUWALL, I. (1975): Copulatory behaviour, gestation and parturition of the tayra (*Eira barbara* L., 1758). *Z. Säugetierkunde* 40, 176–189.
- RICHARDSON, W. B. (1942): Ring-tailed cats (*Bassariscus astutus*): their growth and development. *J. Mammalogy* 23, 17–26.
- TOWELL, D. E. (1976): Den range areas and denning habits of ringtails in Texas (manuscript).
- TRAPP, G. R. (1978): Comparative behavioural ecology of the ringtail and gray fox in southern Utah. *Carnivore* 1, 3–48.

Authors' addresses: Dr. IVO POGLAYEN-NEUWALL, Research Associate, Dept. of Ecology and Evolutionary Biology, University of Arizona, Tucson, Az. 85721; Dr. INGEBORG POGLAYEN-NEUWALL, Curator, Arizona-Sonora Desert Museum, Tucson, Az. 85704, USA